How to Sample Marine Microaggregates in Shallow and Turbid Environments ? Problems and Solutions

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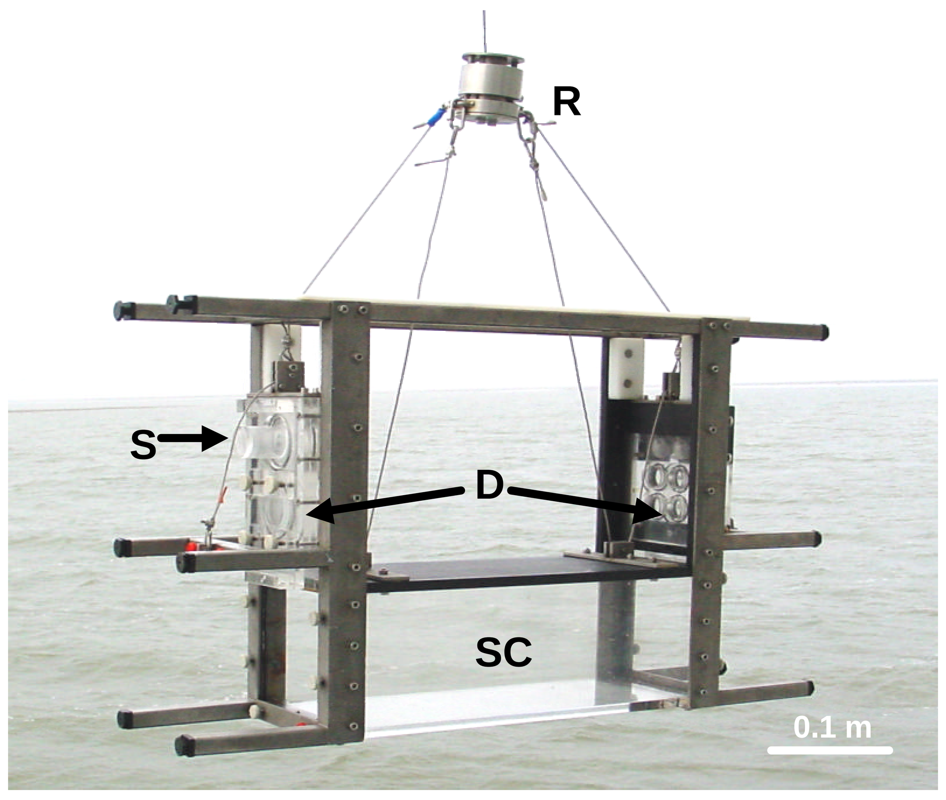

Fig. 1: Details of the newly designed water sampler for shallow and turbid environments: releaser (**R**), sliding doors (**D**), sampling chamber (**SC**), sedimentation chamber (**S**).

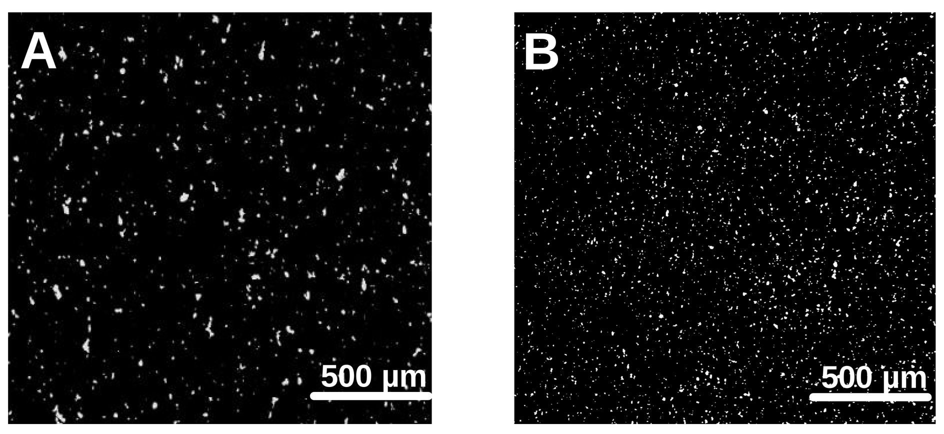

Fig. 2: Digital photos of a fractionated water sample (May 2002, high tide, Otzumer Balje). (A) bulk sample at time 0 and (B) supernatant after 45 min. Camera cut-out and scale is identical in both pictures.

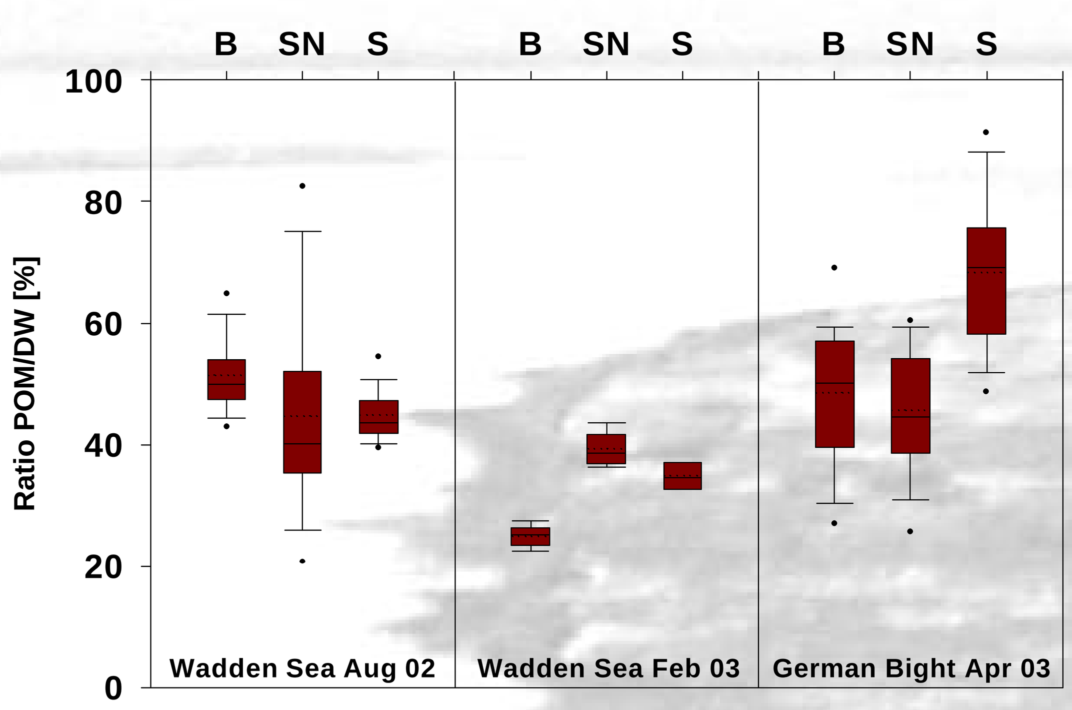

Fig. 3: Ratio of POM/DW from aggregate fractions separated in the sampler (B=bulk sample, t0; SN=supernatant, t=45 min; S=sediment, t=45 min). Wadden Sea: one station (Otzumer Balje) sampled for two tidal cycles; German Bight: 20 different stations sampled within 72 hours; mean: dotted line; median: solid line.

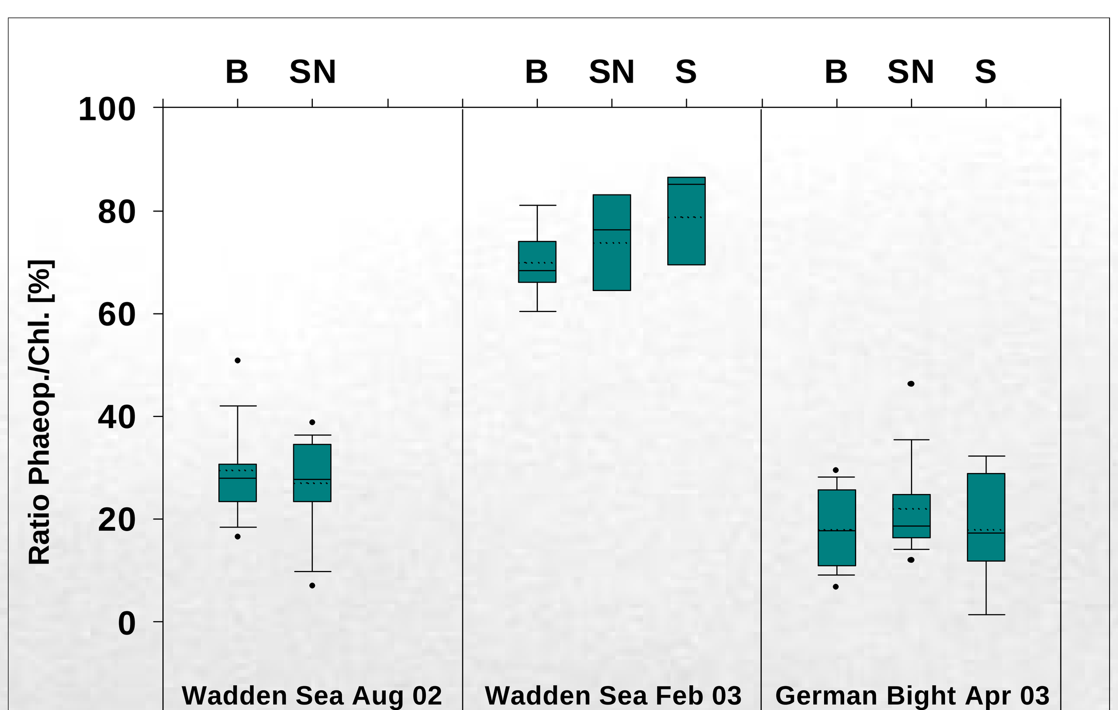

Fig. 4: Ratio of phaeopigments/chlorophyll from aggregate fractions separated in the sampler (B=bulk sample, t0; SN=supernatant, t=45 min; S=sediment, t=45 min). Wadden Sea: one station (Otzumer Balje) sampled for two tidal cycles, German Bight: 20 different stations sampled within 72 hours; mean: dotted line; median: solid line.

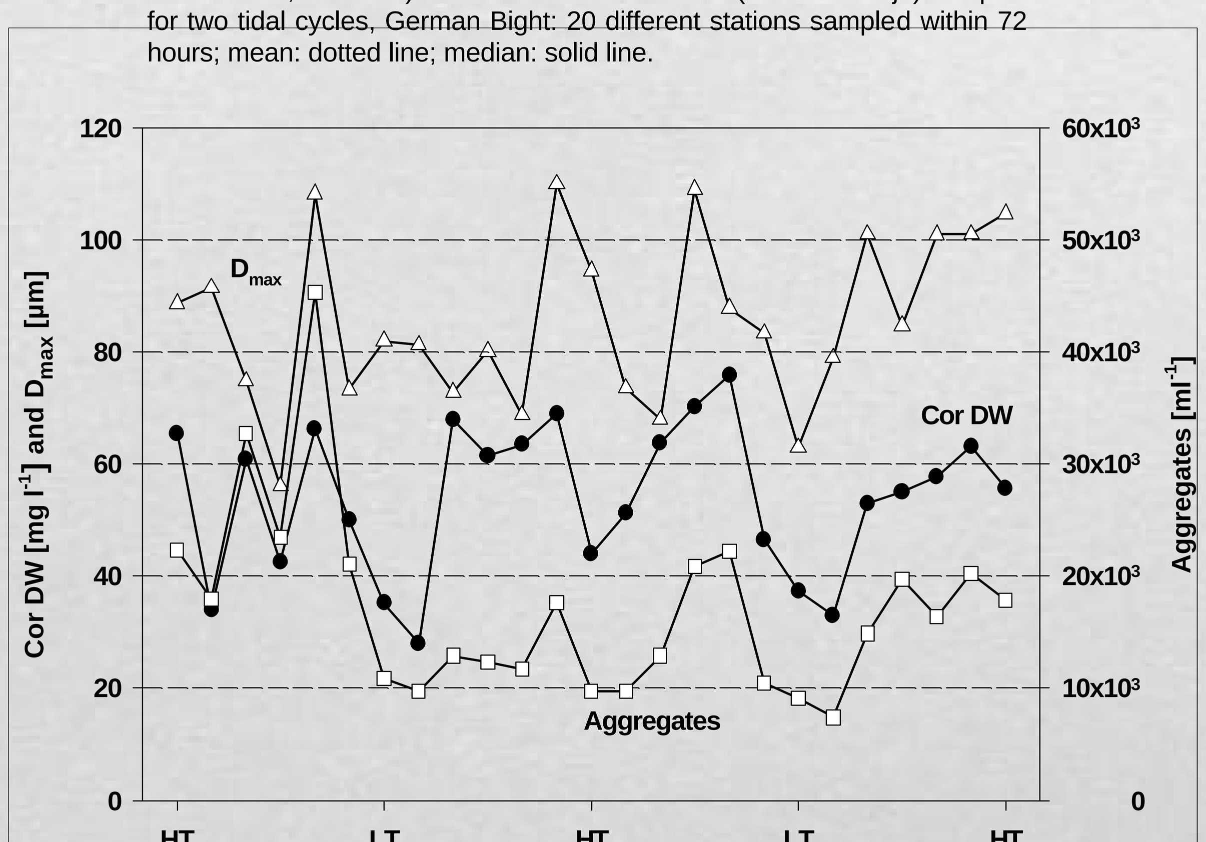

Fig. 5: Dynamics of aggregates >30 µm (February 2003, Otzumer Balje) in terms of dry weight (Cor DW), abundance (Agg Abundance) and maximum diameter (D_{max}).

Total suspended particulate matter (SPM) and particulate organic matter (POM) are basic parameters to determine the composition of microaggregates. Gravimetric estimation of SPM in marine environments after filtration on glass fiber filters is biased by salts which remain in the pore volume of the filter. However, rinsing the filter with distilled water results in a significant loss of POM due to leaching processes.
Furthermore, no basic information about size structure and in situ abundance of microaggregates can be obtained subsequent to filtration.

Aim of the study

(1) To develop an easy method for accurate estimation of SPM (and thus percent of POM)

(2) To design and test a new type of water sampler to sample, document and separate small and fragile aggregates without destroying their size structure.

Conclusion

- Correction of SPM weight for salinity value allows accurate dry weight estimation.
- Rinsing of samples causes significant loss of POM.
- SPM in the Wadden Sea exhibits a substantially higher POM fraction than assumed previously.

Sampler Features

- Soft door closing mechanism enables careful sampling.
- Combination of digital photography, laser illumination and subsequent image analysis allows quick and easy documentation of aggregate size and abundance.
- Opportunity to fractionate different aggregate qualities by size and specific density provides better sample analysis.

Methods

Salt Correction

Dry weight of SPM was estimated by different methods: after sample filtration (1) filters were dried and weighed (DW_{unt} [untreated]), (2) filters were rinsed with 5 ml distilled water and dried and weighed (DW_{rin} [rinsed]). POM was estimated by the difference of DW and ash weight (AW) after combustion. The weight of the rinsed filters was corrected for the loss of POM:

$$DW_{rincor} = DW_{rin} + (POM_{unt} - POM_{rin})\ [mg]$$

To calculate the real DW and AW (Cor DW and AW) without rinsing DW_{unt} was corrected for the salt contained in the pore volume (PV) of the filters (PV=0.51 $\pm$ 0.02 ml, n=5) by using salinity value (Sal) of the original sample expressed as mg ml^{-1}:

$$Cor\ DW = DW_{unt} - (Sal\ [mg/ml] \times PV\ [ml])\ [mg]$$

$$Cor\ AW = AW_{unt} - (Sal\ [mg/ml] \times PV\ [ml])\ [mg]$$

The POM value is not affected by salt and thus calculated by the difference of the untreated DW and AW:

$$POM = DW_{unt} - AW_{unt}\ [mg]$$

Sampler

The doors of the sampler are closed by a remote control while the sampler is in horizontal position and oriented with the current. After bringing it into vertical position on shipboard the aggregates were immediately illuminated by a red light laser. Aggregates were documented using a digital camera and subjected to image analysis for assessing aggregate size classes, area, equivalent circle diameter and abundance. Calibration shows that camera resolution is about 15 µm per pixel.
For fractionation bulk sample are taken (time 0) and the aggregates in the sample are allowed to settle for 45 minutes in the sampler covered by a black PE-jacket. During this time the large and heavier aggregates sink out and accumulate in the connected sedimentation chamber (Fig. 1). Smaller and lighter aggregates remain suspended or even move upwards in the supernatant. The latter fraction is carefully withdrawn by a tube from the top. The photos in Fig. 2 are corrected for brightness and contrast and show the different aggregate structure of the bulk sample at t=0 and the supernatant after 45 min.

Results

Salt correction

DW of unrinsed filters was systematically higher than that of rinsed filters and that corrected for salt (Fig. 6). DW of the rinsed filters and DW corrected for salt are nearly identical (linear regression, r^2=0.98, p<0.001)
Our calculated correction results in reduced DW and unchanged POM values as compared to untreated samples and thus enhance the ratio POM/DW by 84.5 $\pm$ 34.4% (Fig. 7). Loss of POM after rinsing is approximately 52.5 $\pm$ 10.4% (data not shown).

Sampler

Image analysis of the photos provides valuable parameters such as aggregate abundance and size as found in February 2002 (Fig. 5). Also data from other months show similar patterns with close covariations of these parameters to DW and tidal dynamics (data not shown).
The separation of the various fractions by density and size provides new insights in the variation of biological parameters. For example how chlorophyll and POM vary over space and time, such as over tidal cycles in the Wadden Sea and in the German Bight at stations of different states of the phytoplankton spring bloom. (Figs. 3 and 4).

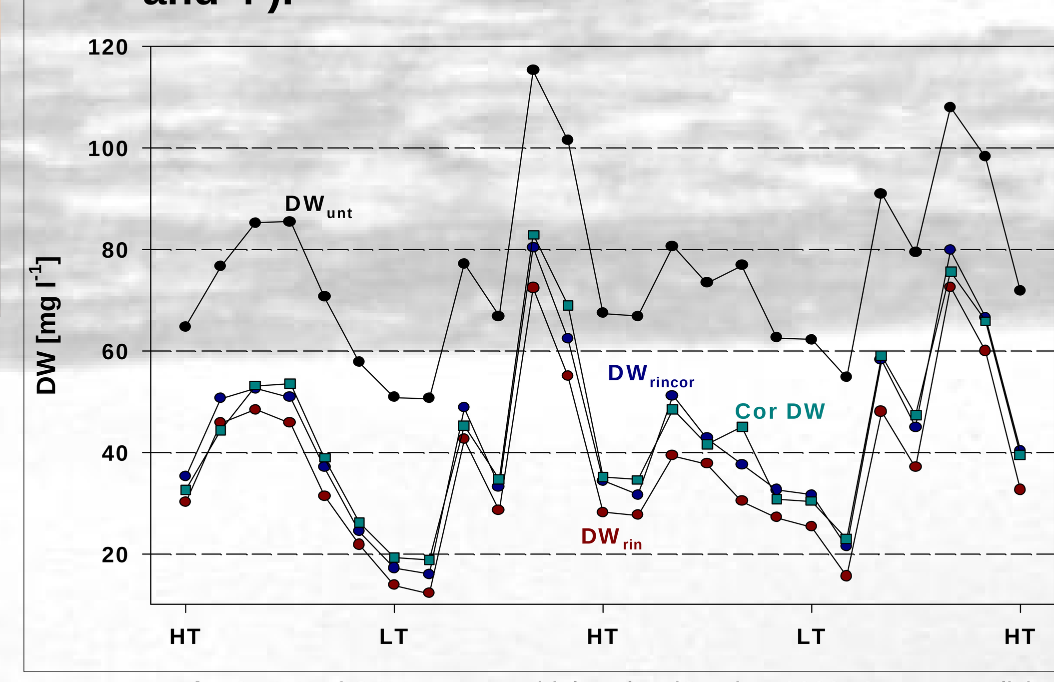

Fig. 6: DW of SPM over two tidal cycles (October 2002, Otzumer Balje) estimated with unrinsed samples (DW unt), rinsed samples (DW rin), rinsed samples corrected for loss of POM (DW rincor) and DW corrected for salt (Cor DW, see text); HT=high tide; LT=low tide.

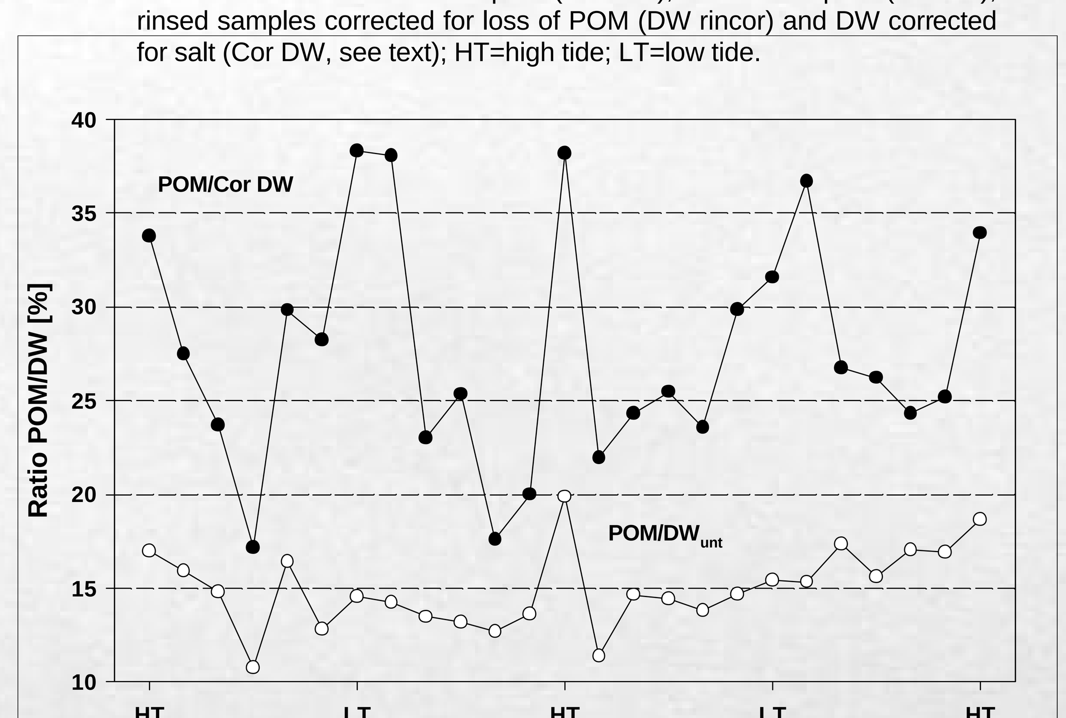

Fig. 7: Ratio of POM/DW in % estimated with untreated (unt) and corrected (Cor) DW in October 2002.

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